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(11) **EP 1 367 671 B1**

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention  
of the grant of the patent:  
28.06.2006 Bulletin 2006/26

(51) Int Cl.:  
*H01Q 9/04* <sup>(2006.01)</sup> *H01Q 1/38* <sup>(2006.01)</sup>  
*H01Q 5/01* <sup>(2006.01)</sup> *H01Q 1/36* <sup>(2006.01)</sup>  
*H01Q 1/24* <sup>(2006.01)</sup>

(21) Application number: **03253337.4**

(22) Date of filing: **28.05.2003**

(54) **Multi-band meander line antenna**

Mäanderförmige Mehrbandantenne

Antenne multibande du type en méandres

(84) Designated Contracting States:  
**DE FR GB**

(30) Priority: **28.05.2002 JP 2002153733**

(43) Date of publication of application:  
**03.12.2003 Bulletin 2003/49**

(60) Divisional application:  
**05021474.1 / 1 617 512**

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## Description

### FIELD OF THE INVENTION

[0001] This invention relates to a multiple band antenna and in particular to an antenna suited for use with a radio communication device in a wireless LAN (local area network), a mobile telephone, Bluetooth, etc.

### BACKGROUND OF THE INVENTION

[0002] At present, in a wireless LAN, a communicating system using a 2.4-GHz band and a communicating system using a 5-GHz band are available and also in a mobile telephone, a communication system using a 0.8-GHz band and a communication system using a 1.5-GHz band are available.

[0003] Formerly, one communication device was able to communicate with another only in one frequency band system. In recent years, however, one communication device that can communicate in two frequency bands systems has also been developed.

[0004] Such a communication device that can communicate in a plurality of frequency bands needs to use a multi-band antenna capable of transmitting and receiving radio waves of a plurality of frequency bands.

[0005] Various types of multi-band antennas are available. For example, "Zukai idoutuushinyou antenna system" written by FUJIMOTO Kyouhei, YAMADA Yoshitake, and TUNEKAWA Kouichi, published by Sougou Denshi Shuppansha discloses an antenna shown in FIG. 6.

[0006] FIG. 6 is a plan view to show an example of a multi-band antenna in a related art. An antenna 100 has two antenna elements 104 and 106 made of conductors placed in parallel on a dielectric substrate 102. Power is supplied to the antenna elements 104 and 106 in parallel through a feeder line 108 divided into two branches at an intermediate point from a signal source (not shown).

[0007] EP 1 146 590, on which the preamble of claim 1 is based, discloses a surface-mounted antenna having a feeding element and a non-feeding element on a dielectric base member. Each element is branched into a pair of meandering electrodes which diverge from one another. Three of the four electrodes extend from a common surface onto respective side surfaces of the base member.

### SUMMARY OF THE INVENTION

[0008] The antenna 100 shown in FIG. 6 has the two antenna elements 104 and 106 placed in parallel as described above. However, if the two antenna elements are thus placed in parallel, the characteristics of the antenna elements are degraded because of electromagnetic interaction between the antenna elements; this is a problem. Specifically, between the two antenna elements 104 and 106, electromagnetic wave flows interfere with each

other and the center frequencies deviate from the intended range and the impedances deviate from the intended range, so that the gains of the antenna elements are reduced.

[0009] On the other hand, to decrease such electromagnetic interaction, the distance between the two antenna elements 104 and 106 may be set to a large distance. However, if the distance is thus set to a large distance, the dimension of the antenna 100 in the width direction (X direction) thereof becomes large; this is a problem.

[0010] Therefore, the invention is intended for solving the above-described problems in the related arts and it is an object of the invention to provide an antenna for making it possible to decrease electromagnetic interaction between antenna elements without upsizing the dimension of the antenna.

[0011] To the end, according to the invention, there is provided a multiple band antenna comprising: a dielectric substrate; and a plurality of antenna elements each comprising a conductor on a same face of the dielectric substrate and provided in a one-to-one correspondence with frequency bands to operate the respective frequency bands, wherein each of the antenna elements has an open end as one end and is connected at an opposite end to a feeder line and comprises a narrow part on the open end side of the element and formed by line with a narrow width and a wide part on the feeder line side of the element and having a wider width than the narrow width of the narrow part, the narrow part is turned in order in substantially the same direction as a width direction of the wide part, to form a meander shape, and the antenna elements have the wide parts joined in one piece forming a predetermined angle with each other so as to share a part of the wide parts, characterized in that said open ends of said antenna elements are on said same face, said narrow part of each antenna element extends to the open end thereof, said predetermined angle is in the range 5° to 50°, and said wide parts of each of the antenna elements are impedance matching parts of the antenna elements.

[0012] Thus, in the antenna of the invention, the antenna elements share a part of the wide parts, so that the dimension of the antenna in the width direction thereof can be lessened accordingly. Since the antenna elements are placed forming the predetermined angle  $\theta$  with each other, the electromagnetic interaction between the antenna elements can be decreased and the characteristics of the antenna elements are not impaired. The wide part is formed by a line having wider width than that of the line forming the narrow part, and is located between the narrow part and the feeder line. The narrow part is formed by a line having a narrower width than that of the line forming the wide part, and has an open end as one end and is connected at an opposite end to the wide part.

[0013] The angle between the antenna elements is set to a value in the range of 5° to 50°, so that a wide bandwidth can be achieved as the signal band of the high-

frequency side.

[0014] In the antenna of the invention, the dielectric substrate may be a print circuit board for mounting parts.

[0015] The dielectric substrate on which the antenna elements are formed may be an antenna-dedicated substrate, but may be a print circuit board for mounting parts on which any other circuitry for communication is constructed, for example.

[0016] According to the invention, there is provided a radio frequency module for transmitting and receiving a signal, the radio frequency module including any of the antennas described above.

[0017] Thus, any of the antennas described above can be applied to the radio frequency module for transmitting and receiving a signal.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a plan view to show an antenna as a first embodiment of the invention;

FIG. 2 is a graph to show the relationship between angle  $\theta$  between first and second antenna elements 14 and 16 and the bandwidth of a signal that can be transmitted and received in the antenna 10 in FIG. 1; FIG. 3 is a plan view to show an antenna as a second embodiment of the invention;

FIG. 4 is a plan view to show an antenna as a third embodiment of the invention;

FIG. 5 is a block diagram to show the configuration of a radio frequency module incorporating the antenna 10 shown in FIG. 1; and

FIG. 6 is a plan view to show an example of a multi-band antenna in a related art.

[Description of Reference Numerals]

[0019]

10, 10', 10":	Antenna
12, 12', 12":	Dielectric substrate
14, 16, 20:	Antenna element
14a, 16a, 20a:	Narrow part
14b, 16b, 20b:	Wide part
14c, 16c, 20c:	Open end
50:	Radio frequency module
52:	Base band IC
54:	RFIC
56, 60:	Low-noise amplifier
58, 62:	Power amplifier
64, 68:	BPF
66, 70:	LPF
72, 74:	Switch
76:	Diplexer
100:	Antenna
102:	Dielectric substrate
104, 106:	Antenna element

108:

Feeder line

#### DETAILED DESCRIPTION OF THE INVENTION

[0020] Referring now to the accompanying drawings, there are shown preferred embodiments of the invention. FIG. 1 is a plan view to show an antenna as a first embodiment of the invention.

[0021] An antenna 10 of the embodiment is used with a radio communication device in a wireless LAN, etc., for example, and operates with two frequency bands of a 2.4-GHz band and a 5-GHz band. The antenna adopts a monopole type in which the line length is one-quarter wavelength.

[0022] As shown in FIG. 1, the antenna 10 of the embodiment includes a dielectric substrate 12 formed preferably of ceramics such as aluminum oxide and glass ceramic, and a first antenna element 14 and a second antenna element 16 formed of a conductor such as Ag, Ag-Pt, Ag-Pd, Cu, Au, W, Mo and Mn and an alloy of at least two of them, on the surface of the dielectric substrate 12.

[0023] The first antenna element 14 is able to operate with the 2.4-GHz band and the second antenna element 16 is able to operate with 5-GHz band. The first, second antenna element 14, 16 has an open end 14c, 16c as one end and a feeding end 18 as an opposite end. The open end 14c, 16c side is linear with a comparatively narrow width, forming a narrow part 14a, 16a. On the feeding end 18 side, a wide part 14b, 16b wider than the narrow part 14a, 16a is formed for impedance matching.

[0024] The embodiment is first characterized by the fact that the first antenna element 14 is placed almost along the length direction (Y direction) of the dielectric substrate 12, that the second antenna element 16 is inclined at a predetermined angle  $\theta$  with respect to the first antenna element 14, and that the first antenna element 14 and the second antenna element 16 have the wide parts 14b and 16b joined in one piece so as to share a part of the wide parts 14b and 16b.

[0025] Thus, the first and second antenna elements 14 and 16 share a part of the wide parts 14b and 16b, so that the wide part occupation area can be lessened accordingly and thus dimension W of the antenna 10 in the width direction (X direction) thereof can be lessened.

[0026] As the wide parts 14b and 16b are joined in one piece, the feeding end 18 is also made common to the first and second antenna elements 14 and 16 and a feeder line (not shown) is connected to the common feeding line 18. That is, power is supplied from a signal source (not shown) via the feeder line (not shown) through the feeding end 18 to the first and second antenna elements 14 and 16. Thus, the feeding end 18 is also made common, thereby eliminating the need for branching the feeding line connected to the feeding end 18 and circumventing complication of the configuration of the feeding line.

[0027] The second antenna element 16 is inclined at the predetermined angle  $\theta$  with respect to the first anten-

na element 14, so that the electromagnetic interaction between the first and second antenna elements 14 and 16 can be decreased and the characteristics of the first and second antenna elements 14 and 16 are not impaired.

**[0028]** FIG. 2 is a graph to show the relationship between the angle  $\theta$  between the first and second antenna elements 14 and 16 and the bandwidth of a signal that can be transmitted and received (VSWR=2) in the antenna 10 in FIG. 1. In FIG. 2, the horizontal axis indicates the angle  $\theta$  (°) between the first and second antenna elements 14 and 16 and the vertical axis indicates the signal bandwidth (MHz). Black dots indicate the case where a signal in the 2.4-GHz band corresponding to the first antenna element 14 is transmitted and received, and black squares indicate the case where a signal in the 5-GHz band corresponding to the second antenna element 16 is transmitted and received.

**[0029]** As seen in FIG. 2, the bandwidth of the signal in the 2.4-GHz band that can be transmitted and received does not much change with change in the angle  $\theta$ , but the bandwidth of the signal in the 5-GHz band that can be transmitted and received largely changes with change in the angle  $\theta$ .

**[0030]** Generally, in the 5-GHz band of the high-frequency side, particularly a wide band is required as the bandwidth; specifically an about 20% of relative bandwidth (bandwidth/center frequency) is required.

**[0031]** Then, in the embodiment, the angle  $\theta$  between the first and second antenna elements 14 and 16 is set to a value in the range of 5° to 50°. Accordingly, 1000 MHz or more can be provided as the bandwidth in the 5-GHz band of the high-frequency side. What value in the range of 5° to 50° to set is determined by making a comparison between the degree of decrease in the electromagnetic interaction between the first and second antenna elements 14 and 16 and the degree of shortening the dimension of the antenna 10.

**[0032]** The embodiment is second characterized by the fact that each of the narrow parts 14a and 16a of the first and second antenna elements 14 and 16 forms a meander shape. Specifically, the narrow part 14a, 16a starts at the corresponding wide part 14b, 16b and projects along the length direction of the wide part from the wide part and is bent toward the width direction of the wide part. Then, the narrow part 14a, 16a is turned in the opposite direction in the width direction and likewise is turned in the opposite direction in the width direction in order and the whole of the narrow part 14a, 16a extends along the length direction. Finally, the narrow part 14a, 16a arrives at the corresponding open end 14c, 16c as the end point. The meander shape may be formed by a curved line, a straight line or a jagged line, or a combination thereof.

**[0033]** Thus, the narrow parts 14a and 16a of the first and second antenna elements 14 and 16 are made each such a meander shape, whereby the lengths of the antenna elements 14 and 16 in the length directions thereof

can be shortened. The narrow part 14a, 16a is turned in the width direction of the wide part 14b, 16b in order, thereby forming the meander shape, so that the wide part 14b, 16b can function sufficiently as the impedance matching part, as mentioned above.

**[0034]** Further, the embodiment is third characterized by the fact that the first and second antenna elements 14 and 16 are formed on the same face of the dielectric substrate 12.

**[0035]** The first and second antenna elements 14 and 16 are thus formed on the same face of the dielectric substrate 12, whereby the manufacturing process can be simplified as compared with the case where the first and second antenna elements 14 and 16 are formed on different planes such as the surface and a side or the back of the dielectric substrate or are formed in the dielectric substrate, for example.

**[0036]** To form the first and second antenna elements 14 and 16 on one surface of the dielectric substrate 12, for example, a method of performing screen printing of silver paste as the shapes of the antenna elements 14 and 16 on the surface of the dielectric substrate 12 and then baking at a predetermined temperature can be used.

**[0037]** As described above, according to the invention, the first and second antenna elements 14 and 16 share a part of the wide parts 14b and 16b, so that the dimension W of the antenna 10 in the width direction thereof can be lessened. Since the second antenna element 16 is inclined at the predetermined angle  $\theta$  with respect to the first antenna element 14, the electromagnetic interaction between the first and second antenna elements 14 and 16 can be decreased and the characteristics of the antenna elements 14 and 16 are not impaired. Particularly, the angle  $\theta$  is set to a value in the range of 5° to 50°, so that 1000 MHz or more can be provided as the bandwidth in the 5-GHz band of the high-frequency side.

**[0038]** Next, FIG. 3 is a plan view to show an antenna as a second embodiment of the invention. An antenna 10' of the embodiment differs from the antenna 10 of the first embodiment in that in the first embodiment, the first antenna element 14 is placed almost along the length direction of the dielectric substrate 12 and the second antenna element 16 is inclined relative to the first antenna element 14; while, in the second embodiment, a first antenna element 14' is placed in a slanting position relative to the length direction (Y direction) of a dielectric substrate 12' and a second antenna element 16' is inclined relative to the first antenna element 14'. That is, the first and second antenna elements 14' and 16' are placed in slanting positions relative to the length direction (Y direction) of the dielectric substrate 12'.

**[0039]** In the second embodiment, as the antenna elements 14' and 16' are placed on the dielectric substrate 12' as described above, functions similar to those of the antenna of the first embodiment can be accomplished and similar advantages to those in the first embodiment can be provided.

**[0040]** Next, FIG. 4 is a plan view to show an antenna

as a third embodiment of the invention. An antenna 10" of the embodiment differs from the antenna 10 of the first embodiment in that in the first embodiment, the antenna 10 includes the two antenna elements; while, the antenna 10" of the second embodiment includes three antenna elements. That is, the antenna 10" of the embodiment operates with three frequency bands systems as a third antenna element 20 is added to first and second antenna elements 14 and 16.

[0041] Like the first, second antenna element 14, 16, the added third antenna element 20 has an open end 20c as one end and a feeding end 18 as an opposite end. On the open end 20c side, a narrow part 20a is formed and on the feeding end 18 side, a wide part 20b is formed.

[0042] Like the second antenna element 16, the third antenna element 20 is inclined at a predetermined angle  $\theta$ " with respect to the first antenna element 14 and in addition, the first, second, and third antenna elements 14, 16, and 20 have wide parts 14b, 16b, and 20b joined in one piece so as to share a part of the wide parts 14b, 16b, and 20b.

[0043] Like a narrow part 14a, 16a of the first, second antenna element 14, 16, the narrow part 20a of the third antenna element 20 forms a meander shape. Further, the third antenna element 20 is also formed on the same face of a dielectric substrate 12" as the first and second antenna elements 14 and 16 are formed.

[0044] Since the third antenna element 20 is thus configured, the antenna 10" of the embodiment basically can accomplish functions similar to those of the antenna of the first embodiment and can provide similar advantages to those in the first embodiment and further operates with three frequency bands systems.

[0045] The antenna 10, 10', 10" in the first to third embodiments described above is installed in a radio communication device in a wireless LAN, etc., as one component of a radio frequency module, for example.

[0046] Then, such a radio frequency module incorporating the antenna 10, 10' of the embodiment will be discussed briefly.

[0047] FIG. 5 is a block diagram to show the configuration of a radio frequency module incorporating the antenna 10 in FIG. 1.

[0048] As shown in FIG. 5, a radio frequency module 50 includes a base band IC 52, a radio frequency (RF) IC 54, low-noise amplifiers 56 and 60, power amplifiers 58 and 62, band-pass filters (BPFs) 64 and 68, low-pass filters (LPFs) 66 and 70, switches 72 and 74, a diplexer 76, and the antenna 10 in FIG. 1. The low-noise amplifier 56, the power amplifier 58, the BPF 64, the LPF 66, and the switch 72 are a circuit for the 2.4-GHz band, and the low-noise amplifier 60, the power amplifier 62, the BPF 68, the LPF 70, and the switch 75 are a circuit for the 5-GHz band.

[0049] The base band IC 52 controls the RFIC 54 and transfers a low-frequency signal to and from the RFIC 54. The RFIC 54 converts a low-frequency transmission signal received from the base band IC 52 into a radio

frequency signal and converts a radio frequency reception signal into a low-frequency signal and passes the low-frequency signal to the base band IC 52.

[0050] The diplexer 76 performs band switching between 2.4-GHz and 5-GHz bands. Specifically, to communicate in the 2.4-GHz band, the diplexer 76 connects the antenna 10 and the circuit for the 2.4-GHz band; to communicate in the 5-GHz band, the diplexer 76 connects the antenna 10 and the circuit for the 5-GHz band.

[0051] Each of the switches 72 and 74 switches the signal path in response to transmission or reception. Specifically, to receive a signal, the signal path on the BPF side is selected; to transmit a signal, the signal path on the LPF side is selected.

[0052] Therefore, for example, if communications are conducted in the 2.4-GHz band and the antenna 10 receives a signal, the reception signal is input through the diplexer 76 and the switch 72 to the BPF 64 and is subjected to band limitation through the BPF 64 and then the signal is amplified by the low-noise amplifier 56 and is output to the RFIC 54. The RFIC 54 converts the reception signal from the 2.4-GHz band to a low-frequency band and passes the conversion result to the base band IC 52.

[0053] In contrast, to transmit a signal through the antenna 10, a low-frequency transmission signal is passed from the base band IC 52 to the RFIC 54, which then converts the transmission signal from a low-frequency band to the 2.4-GHz band. The transmission signal is amplified by the power amplifier 58 and then the low-frequency band is cut through the LPF 66 and then the signal is transmitted from the antenna 10 through the switch 72 and the diplexer 76.

[0054] On the other hand, to communicate in the 5-GHz band, using the circuit for the 5-GHz band, processing involved in transmission and reception is performed according to a similar procedure to that of communications in the 2.4-GHz band, and a signal is transmitted and received using the same antenna 10 as used in the 2.4-GHz band.

[0055] It is to be understood that the invention is not limited to the specific embodiments thereof. For example, at least part of each antenna element may be covered with an insulation layer. The insulation layer preferably comprises a ceramic which may be the same as that of the dielectric substrate or a resin such as an epoxy resin and a phenol resin. The thickness of the insulation layer is not limited, but, preferably from 10 to 100  $\mu\text{m}$ .

[0056] In the above-described embodiments, antenna-dedicated boards are used as the dielectric substrates 12, 12', and 12", but print circuit boards for mounting parts may be used in place of the dedicated boards. For example, to apply the antenna of the invention to a radio frequency module as shown in FIG. 5, the antenna elements making up the antenna of the invention may be formed in a partial area of the print circuit board on which a part or all of the radio frequency module is constructed.

[0057] In the embodiments, the case where the anten-

na is used with a radio communication device in a wireless LAN, etc., is described, but the antenna may be used with a radio communication device in a mobile telephone, Bluetooth, etc.

[0058] In the embodiments, the antennas for operating with two or three frequency bands systems are described, but if the number of antenna elements is increased to four, five, or more, the antenna can operate with as many frequency bands systems as the number of antenna elements. In this case, the angle between one pair of the antenna elements may be the same as or different from the angle between another pair of the antenna elements.

#### Claims

1. A multiple band antenna (10; 10'; 10'') comprising:
  - a dielectric substrate (12; 12'; 12''); and
  - a plurality of antenna elements (14, 16; 14', 16'; 14, 16, 20) each comprising a conductor on a same face of the dielectric substrate (12; 12', 12'') and provided in a one-to-one correspondence with frequency bands to operate the respective frequency bands, wherein
  - each of the antenna elements has an open end (14c, 16c; 14c, 16c, 20c) as one end and is connected at an opposite end to a feeder line (18) and comprises a narrow part (14a, 16a; 14a, 16a, 20a) on the open end side of the element and formed by line with a narrow width and a wide part (14b, 16b; 14b, 16b, 20b) on the feeder line side of the element and having a wider width than the narrow width of the narrow part, the narrow part is turned in order in substantially the same direction as a width direction of the wide part, to form a meander shape, and the antenna elements have the wide parts joined in one piece forming a predetermined angle ( $\theta$ ;  $\theta'$ ;  $\theta$ ,  $\theta''$ ) with each other so as to share a part of the wide parts,
  - characterized in that said open ends of said antenna elements are on said same face,
  - said narrow part of each antenna element extends to the open end thereof,
  - said predetermined angle is in the range  $5^\circ$  to  $50^\circ$ , and
  - said wide parts of each of the antenna elements are impedance matching parts of the antenna elements.
2. A multiple band antenna (10, 10', 10'') according to claim 1, which operates with two frequency bands of a 2.4-GHz band and a 5-GHz band.
3. A multiple band antenna (10; 10'; 10'') according to claim 1 or claim 2, wherein the dielectric substrate

(12; 12'; 12'') is a print circuit board for mounting parts.

4. A multiple band antenna (10; 10'; 10'') according to claim 3, wherein the print circuit board mounts parts for a radio communication device.
5. A multiple band antenna (10; 10'; 10'') according to any one of claims 1 to 4, wherein at least one of the antenna elements is placed almost along a length direction of the dielectric substrate (12, 12', 12'').
6. A multiple band antenna (10') according to any one of claims 1 to 4, wherein all of the antenna elements (14', 16') are placed in a slanting position relative to a length direction of the dielectric substrate (12').
7. A multiple band antenna (10; 10'; 10'') according to any one of claims 1 to 6, wherein each of the antenna elements has a different line length.
8. A radio frequency module (50) for transmitting and receiving a signal, comprising the multiple band antenna (10; 10'; 10'') according to any one of claims 1 to 7.
9. A radio frequency module (50) according to claim 8, which further comprises a switch (72, 74) for switching a signal path in response to transmission or reception.

#### Patentansprüche

1. Mehrbandantenne (10; 10'; 10''), die aufweist:
  - ein dielektrisches Substrat (12; 12'; 12''); und
  - eine Mehrzahl von Antennenelementen (14, 16; 14', 16'; 14, 16, 20), wobei jedes einen Leiter auf derselben Fläche des dielektrischen Substrats (12; 12'; 12'') aufweist und in einer eins zu eins Beziehung zu Frequenzbändern vorgesehen ist, um die jeweiligen Frequenzbänder zu betreiben, wobei
  - jedes der Antennenelemente ein offenes Ende (14c, 16c; 14c, 16c, 20c) als ein Ende besitzt und mit einem entgegengesetzten Ende zu einer Zuführleitung (18) verbunden ist und einen schmalen Teil (14a, 16a; 14a, 16a, 20a) auf der Seite des offenen Endes des Elements aufweist und durch eine Leitung mit einer schmalen Breite und einem breiten Teil (14b, 16b; 14b, 16b, 20b) auf der Seite der Zuführleitung des Elements ausgebildet ist und eine breitere Breite als die schmale Breite des schmalen Teils besitzt,

wobei der schmale Teil in der Reihenfolge im We-

sentlichen in derselben Richtung wie eine Breitenrichtung des breiten Teils gedreht ist, um eine Mäanderform zu bilden, und  
 die Antennenelemente die breiten Teile in einem Stück, einen vorgegebenen Winkel ( $\theta$ ;  $\theta'$ ;  $\theta$ ,  $\theta''$ ) zueinander bildend, um so gemeinsam einen Teil der breiten Teile zu teilen, verbunden haben,  
**dadurch gekennzeichnet, dass** die offenen Enden der Antennenelemente auf derselben Fläche vorhanden sind,  
 dass sich der schmale Teil jedes Antennenelements zu dem offenen Ende davon erstreckt,  
 dass der vorgegebene Winkel in dem Bereich von  $5^\circ$  bis  $50^\circ$  liegt, und  
 dass die breiten Teile jedes der Antennenelemente Impedanzanpassungsteile der Antennenelemente sind.

2. Mehrfachbandantenne (10; 10'; 10'') nach Anspruch 1, die mit zwei Frequenzbändern mit einem 2,4-GHz Band und einem 5-GHz Band arbeitet. 20
3. Mehrfachbandantenne (10; 10'; 10'') nach Anspruch 1 oder Anspruch 2, wobei das dielektrische Substrat (12; 12'; 12'') eine gedruckte Schaltungsleiterplatte zum Montieren von Teilen ist. 25
4. Mehrfachbandantenne (10; 10'; 10'') nach Anspruch 3, wobei die gedruckte Schaltungsleiterplatte Teile für eine Funkübertragungsvorrichtung befestigt. 30
5. Mehrfachbandantenne (10; 10'; 10'') nach einem der Ansprüche 1 bis 4, wobei mindestens eines der Antennenelemente nahezu entlang einer Längsrichtung des dielektrischen Substrats (12; 12'; 12'') platziert ist. 35
6. Mehrfachbandantenne (10') nach einem der Ansprüche 1 bis 4, wobei alle Antennenelemente (14', 16') in einer schrägen Position relativ zu einer Längsrichtung des dielektrischen Substrats (12') platziert sind. 40
7. Mehrfachbandantenne (10; 10'; 10'') nach einem der Ansprüche 1 bis 6, wobei jedes der Antennenelemente eine unterschiedliche Leitungslänge hat. 45
8. Funkfrequenzmodul (50) zum Senden und Empfangen eines Signals, das die Mehrfachbandantenne (10; 10'; 10'') nach einem der Ansprüche 1 bis 7 aufweist. 50
9. Funkfrequenzmodul (50) nach Anspruch 8, das weiterhin einen Schalter (72, 74) zum Umschalten eines Signalpfads in Abhängigkeit eines Sendens oder eines Empfangs aufweist. 55

## Revendications

1. Antenne multibande (10 ; 10' ; 10'') comprenant :

un substrat diélectrique (12 ; 12' ; 12'') ; et  
 une pluralité d'éléments d'antenne (14, 16 ; 14', 16' ; 14, 16, 20) dont chacun comprend un conducteur sur une même face du substrat diélectrique (12 ; 12' ; 12'') et qui sont munis selon une correspondance biunivoque de bandes de fréquences pour faire fonctionner les bandes de fréquences respectives,

dans laquelle :

chacun des éléments d'antenne comprend une extrémité ouverte (14c, 16c ; 14c, 16c, 20c) en tant qu'une extrémité et est connecté au niveau d'une extrémité opposée à une ligne de moyen d'alimentation (18) et comprend une partie étroite (14a, 16a ; 14a, 16a, 20a) sur le côté d'extrémité ouverte de l'élément et formée par une ligne présentant une largeur étroite et une partie large (14b, 16b ; 14b, 16b, 20b) sur le côté de ligne de moyen d'alimentation de l'élément et présentant une largeur plus large que la largeur étroite de la partie étroite,  
 la partie étroite est recourbée selon sensiblement la même direction qu'une direction de largeur de la partie large afin de former une forme en méandre ; et  
 les éléments d'antenne comportent les parties larges jointes selon une seule pièce formant un angle prédéterminé ( $\theta$  ;  $\theta'$  ;  $\theta$ ,  $\theta''$ ) les unes par rapport aux autres de manière à partager une partie des parties larges,

**caractérisée en ce que** lesdites extrémités ouvertes desdits éléments d'antenne sont sur ladite même face,  
 ladite partie étroite de chaque élément d'antenne s'étend jusqu'à son extrémité ouverte,  
 ledit angle prédéterminé est dans la plage de  $5^\circ$  à  $50^\circ$  ; et  
 lesdites parties larges de chacun des éléments d'antenne sont des parties d'adaptation d'impédance des éléments d'antenne.

2. Antenne multibande (10, 10', 10'') selon la revendication 1, qui fonctionne avec deux bandes de fréquences qui sont une bande à 2,4 GHz et une bande à 5 GHz.
3. Antenne multibande (10 ; 10' ; 10'') selon la revendication 1 ou 2, dans laquelle le substrat diélectrique (12 ; 12' ; 12'') est une carte de circuit imprimé pour monter des parties.

4. Antenne multibande (10 ; 10' ; 10") selon la revendication 3, dans laquelle la carte de circuit imprimé reçoit en montage des parties pour un dispositif de communication radio. 5
5. Antenne multibande (10; 10' ; 10") selon l'une quelconque des revendications 1 à 4, dans laquelle au moins l'un des éléments d'antenne est placé pratiquement suivant une direction de longueur du substrat diélectrique (12 ; 12' ; 12"). 10
6. Antenne multibande (10') selon l'une quelconque des revendications 1 à 4, dans laquelle tous les éléments d'antenne (14', 16') sont placés selon une position d'inclinaison par rapport à une direction de longueur du substrat diélectrique (12'). 15
7. Antenne multibande (10; 10' ; 10") selon l'une quelconque des revendications 1 à 6, dans laquelle chacun des éléments d'antenne présente une longueur de ligne différente. 20
8. Module haute fréquence (50) pour émettre et recevoir un signal, comprenant l'antenne multibande (10 ; 10' ; 10") selon l'une quelconque des revendications 1 à 7. 25
9. Module haute fréquence (50) selon la revendication 8, lequel comprend en outre un commutateur (72, 74) pour commuter une voie de signal en réponse à une émission ou à une réception. 30

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FIG. 1

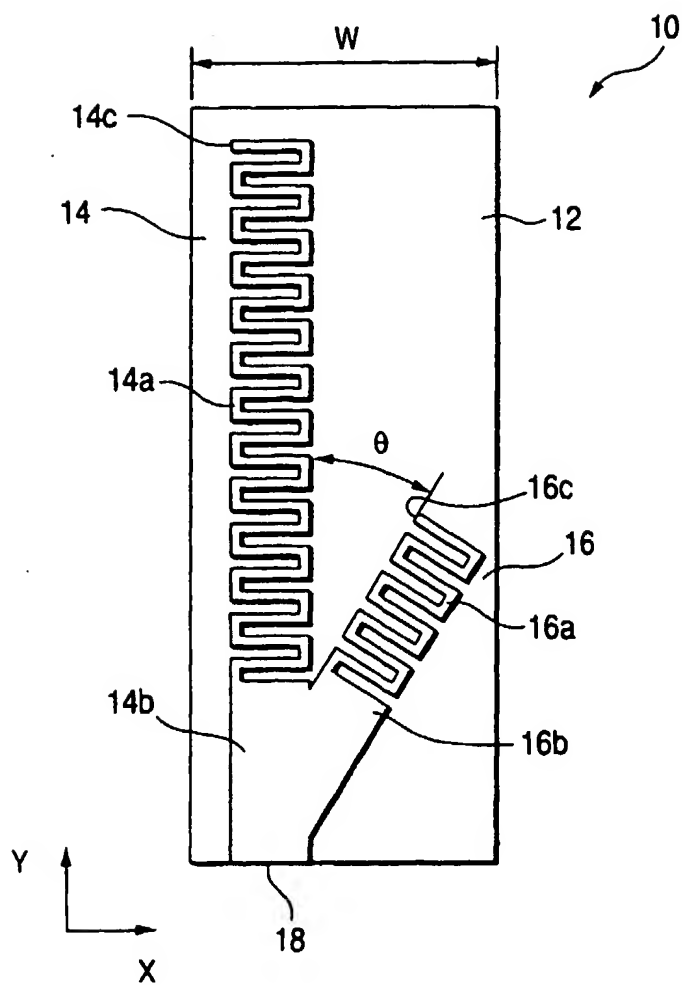


FIG. 2

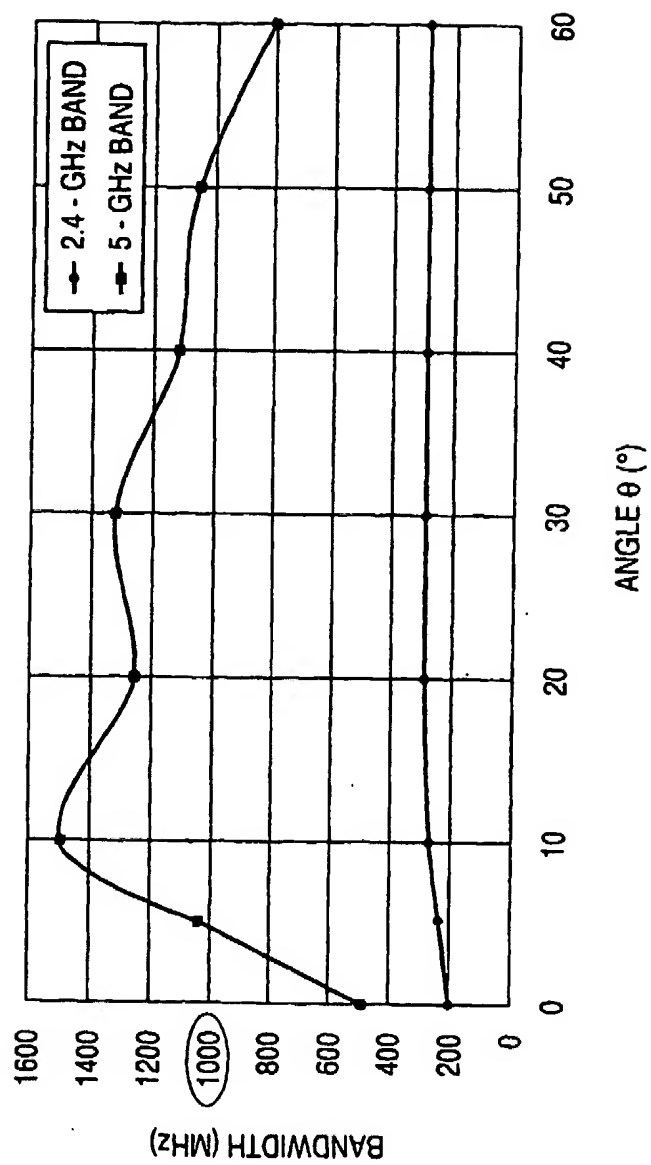


FIG. 3

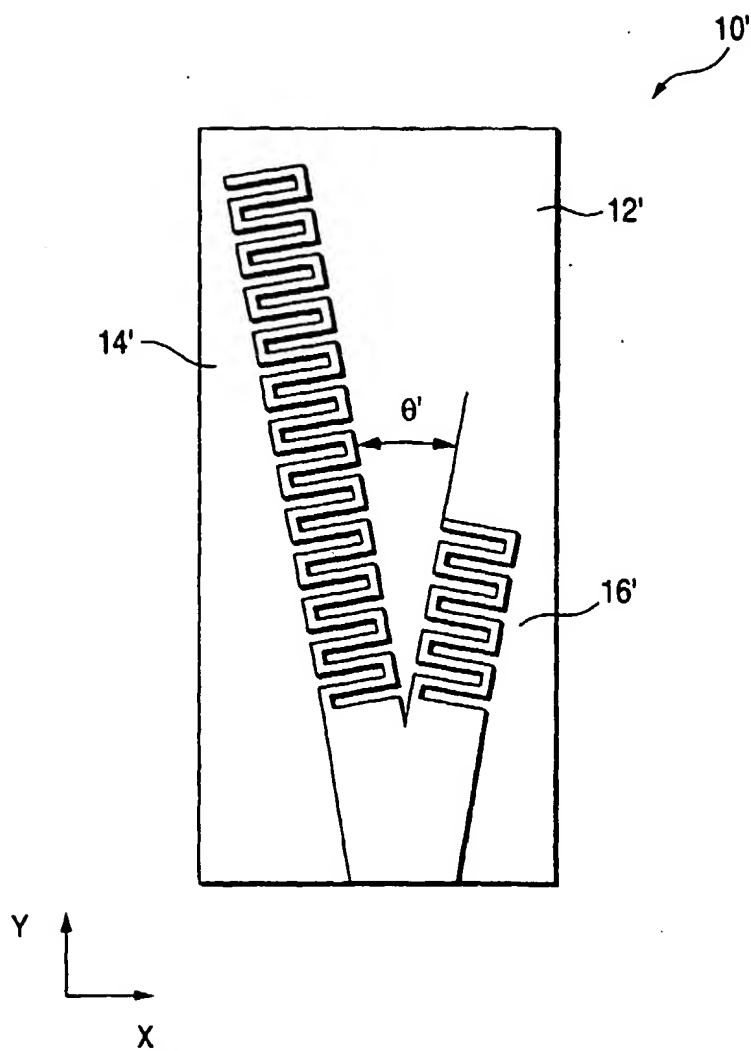


FIG. 4

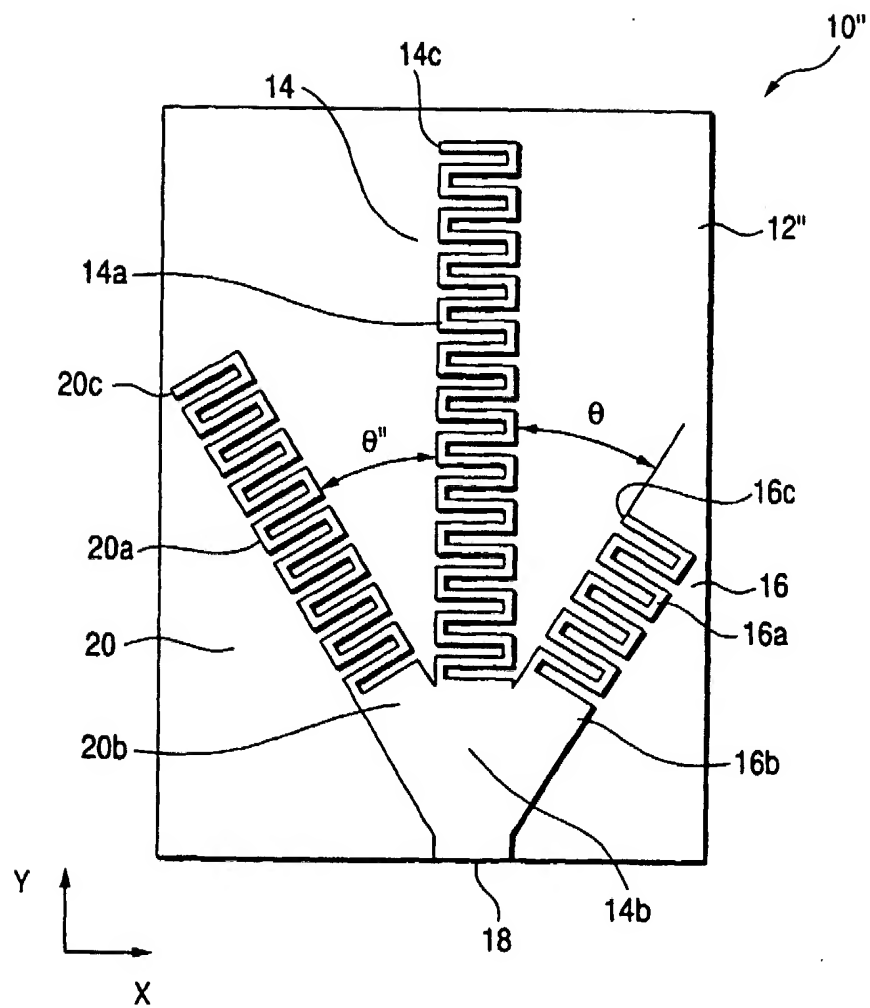


FIG. 5

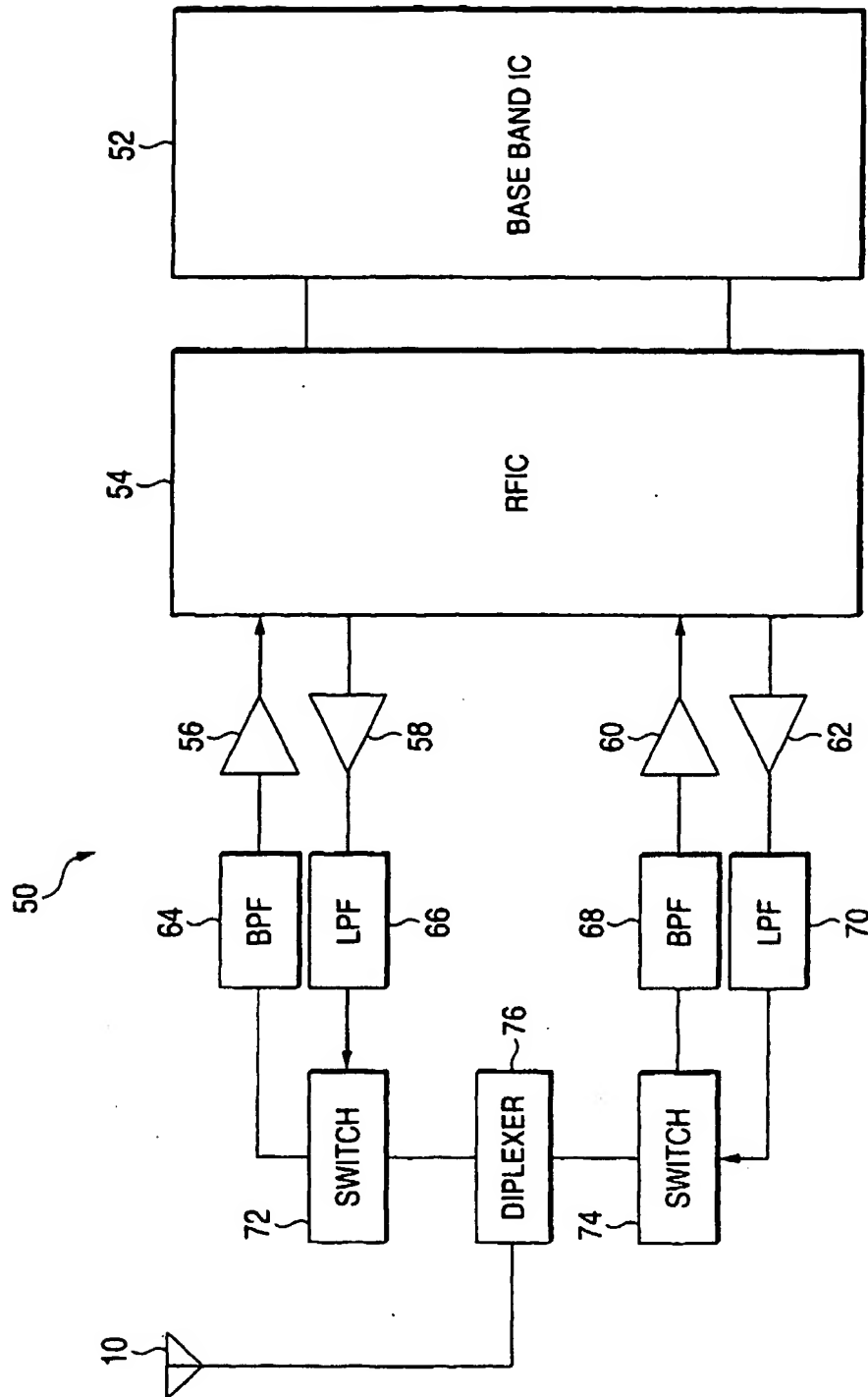


FIG. 6

